

Row 1, Extraction

- What to do with the water
 - Often high quality
- No infrastructure
- Treatment
- Water rights holders/conflicts
 - Juniors (producers) vs seniors (concerned with effect on their water drawdown?)
- Regulated as waste product
- Oil wells—lower quality water
- Gas wells—higher quality water
- Reinjection can be a “loss” if it goes into lower quality aquifer
- Problem of collecting
- Collection/distribution cost issue
- Relates to life of generation (50-60 years)
 - Finding customer because of short-term
 - 13000 wells, 150 bbl/day, 7-10 years
 - 40k wells
- Oil shale—long term
 - High water use
 - Water quality degradation
 - Worth the tradeoffs?
- Oil production
 - Reinjection to maintain pressure
- Regulation of produced water
- Water rights
 - Transboundary water supply/conflicts
- Coal extraction
 - Dust suppression, washing, etc.
 - Water quality impacts
- Coal gasification—clean coal
 - Water use in extraction
 - Less cooling water
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Row 2, Fuel Production

- Alternative fuel production; biomass ethanol
 - More demand on water supply

Row 3, Electricity Production

- Nuclear—water supply issues
 - Need water supply—high extraction
 - Water temperature effects
 - Cooling requirements slightly higher than coal plant

- 2.4 bgd—San Onofre
- Dry cooling
 - Gets water issue off table
- Coal fired
 - Regulatory treatment of costs
 - Costs—relates to rates
 - Water costs
 - NIMBY

Row 4, Renewables

- Geothermal water
 - Poor quality after extraction
 - Need cooling towers
 - Can reinject
 - For geothermal, some lack of water and compete for
- Subsidence problems
 - Can be significant environmental problems; effect on instream flows; lag effects
- Hydropower
 - Climate change—direct impact on hydropower
 - For cooling
 - For demand
 - Snowpack decreasing
 - Seasonal water flows
 - Exacerbates all ecosystem effects
- Pumped storage
 - Presents ESA issues
- Biofuel (methane)
 - Needs turbine/water
 - Can be a water producer
 - Site specific
 - Cost effectiveness
 - Scale
 - Storage capability
 - Seasonal needs and water supply
- Biomass
 - Water needs
- Solar/wind
 - Problem of scale
 - Storage
 - Transmission
- Hydrogen—too long term?
- Role of conservation?

Row 5, Energy, Other

- Cost/value of water

- Regulations (inadequate)
 - Can't allow externalities
- Price signal inadequate
- Water rates—low
- General Problem: transporting water
 - Costs of infrastructure
 - Costs of power to transport
 - Legal issues
 - Different laws and regulations
- Economics of treatment
 - Related to price of gas
 - Higher cost of water treatment
 - Could lead to less production
- Cross-border externalities
 - Re: production and users
 - Producing in water short areas and exporting to energy consuming areas

Grouping/Voting

Extraction

- Treatment/disposal of produced water
- Water rights conflicts (5 votes)
 - Impairment of existing/senior rights)
- Collection/transmission of produced water—costly (5 votes)
 - Requires energy and infrastructure

Electricity Generation

- Rising energy demand/water supply
- Water quality (temperature) is impaired
- Lack of water valuation and regulatory treatment of water costs (11 votes)
- Current thermo-electric cooling technologies are water intensive (7 votes)

Renewable Sources

- Production of biomass/fuels requires large water supply (2 votes)
- Solar and wind require storage that uses water
- Hydrogen energy production is not energy/water efficient (1 vote)
- Hydropower is impacted by climate change (4 votes)

Regulatory/Economic

- Cross-boundary regulatory conflicts impede water transfer and use (8 votes)
 - Externalities—benefit and burden are remote (2 votes)
- Costs (see above)
- Water quality and discharge requirements impact cost and supply of water and energy (3 votes)

Row 6, Urban Uses

- Urban use is only 3% of total water use
 - All new applications are protested
 - No look at common goal and common picture
 - Supporting price of old water
 - Lack of regional planning
- Institutions don't match changing demands
 - Inflexibility
- Regulations have unintended consequences
- In transition; to more market transactions
 - Between ground and surface
- Market issues—lack of transparency
- Unsettle tribal water rights
- Rate structures
- Subsidies
- Fragmented education re: water
- Separation of water quality and quantity
- Ag water being tapped for cities
 - Politically difficult
- Pumped groundwater—not sustainable supply
- Urban water poses water quality threat
- Unmanaged riparian vegetation takes water
 - How to allocate water that gets saved
- Wasteful water expensive to cities
- Geography of availability
 - Pipelines, transportation
- No champion of riparian areas
 - Aesthetics/habitat
 - Environment loses to urban uses

Row 7, Agricultural Uses

- Subsidies force bad choices
- Unsustainable groundwater pumping
- Policies encourage urban/ag efficiencies but there are negative environmental impacts from some efficiencies
- Non-point source pollution from ag
 - Ag may need to treat return flows
- Some ag not sustainable (groundwater depletion)
- Need more understanding about water situation
- Lack of understanding of water interconnections
- Huge social, economic, political issues
 - Program structure needs to include these issues
- SOLN: NOAA—to understand social and economic drivers, regional issues with help of scientists and science

- Ag—efficiencies, problems
 - Cultural
 - Water rights engineering
 - Costs to conserve
 - Recharge
 - Riparian habitat

Rows 8 and 9, Electricity and Energy Production Uses

- How much land is available for biomass
 - Who are producers
 - Losing soil
- Lack of coordination between farm/energy interests
- Scale of problem
 - SOLN: pellets
- Contingency uses—problems with regulation and laws
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Row 10, Recreation/Environment

- Effects of mitigating flows—no willing sellers
- Seasonal flows—timing of releases
- Kayak courses—need instream flow
- Junior rights
- Competing values
- Recreation of historic flow regimes competes with all other uses
- Environment standards, benchmarks
- Conflicts
 - Rafting v flatwater

Grouping/Voting

- Transportation
 - Getting available water to where it's needed (2 votes)
- Urban
 - New water permits protested
 - Pumped groundwater not sustainable (2 votes)
 - Lost of non-regulated groundwater use (1 vote)
 - Institutions don't match changing demands (7 votes)
 - Rate structures don't properly value water (3 votes)
 - Unmanaged riparian vegetation uses water
 - Urban users are wasteful and contaminate water
- Agriculture
 - Non-point source pollution of ag not regulated (2 votes)
 - Unsustainable groundwater pumping (2 votes)

- Evaporative losses are significant—center pivot irrigation
- Ag efficiencies not well understood and have unintended consequences (2 votes)
- Recreation/Environment
 - Habitat protection conflicts with human use (4 votes)
 - Recreation of historic flow regimes competes with all other uses and thus is difficult to protect ecosystems.
 - Rivers are being dried up for human use with significant ecosystem implications (1 vote)
- Water Policy
 - Lack of public knowledge leads to poor policy decisions regarding water use and supplies (2/3 votes)
 - Lack of interdisciplinary knowledge (3 votes)
 - Unresolved tribal claims (2 votes)
 - Fragmentation ground and surface water management (9 votes)
 - Need for response to climate change (3 votes)

Random Problems

- There are opportunities for water efficiencies
- We treat most water to the highest use

Priority Problem: Lack of water valuation and regulatory treatment of water costs.

- NEED: Visionary politicians
- NEED: Prioritize use
- NEED: Research for institutional solutions
- NEED: Federal assistance for drought planning
- NEED: Laws and policies to allow flexibility
- NEED: Identify a range of stakeholder-driven processes to allow communities to manage their water
- NEED: Treat as community resource (1 vote)
- NEED: Coordinate water policy and water programs among federal agencies
- NEED: Secretary of Water
- NEED: A system to provide incentives for conservation (5 votes)
 - Optimization
 - A suite of solutions/options
 - Recognize watersheds
- NEED: Openness in water transactions; incentives and transparency for collaborative processes
- NEED: Better data on water availability related to energy needs
- NEED: Tools and methods for site-specific energy/water planning
 - Stakeholder-driven

Priority Problem: Crossboundary Conflicts

- NEED: Facilitate collaboration across boundaries—tribes, states, cities, political subdivisions
- NEED: Look at water/energy issues on a watershed basis (1 vote)
- NEED: Funds and incentives to support collaborations

Priority Problem: Thermoelectric Cooling

- NEED: Low emission, low water use thermoelectric power
- NEED: More efficient cooling systems that use less water
- NEED: Rate relief for new technology (IGCC) (pre-approval) or federal incentives (5 votes)
 - Risk mitigation: DOE; work with state regulators to reduce risk on new technologies
- NEED: Relation between treatment technology, energy and water use (1 vote)
- NEED: Research/study to reduce retrofit costs to reduce once-through cooling (2 votes)

Priority Problem: Fragmented ground/surface water

- NEED: Better characterization and understanding of interactions between groundwater and surface water
- NEED: Educate water managers and policy makers and public about (where water comes from) interactions between ground and surface water (2 votes)
- NEED: More cheaply measure and monitor groundwater and surface flows

Priority Problem: Climate Change

Collection/transmission of water

Habitat issue

- NEED: Planning to incorporate impacts of climate change
- NEED: Include water managers in climate change planning
- NEED: Incorporate current knowledge of climate change into water policy and planning (3 votes)
- NEED: Connect science and decisionmaking (4 votes)
- NEED: Research to understand effects of climate change on hydrological cycle (3 votes)
- NEED: Translating science for policymakers
- NEED: Probabilistic outcomes/predictions
 - Temporal and spatial distributions
- NEED: Modeling—with \$ figures for impacts (1 vote)
- NEED: Link economic models to physical models, with scenarios and \$\$ impacts

Priority Problem: Collection/Transmission of Water

Infrastructure, Pumping, Permitting

- NEED: More cost-effective piping
- NEED: Cheaper treatment options (2 votes)—energy requirements
- NEED: Less energy intensive ways to treat water
 - More—new—infrastructure
- NEED: Synergistic solutions re: energy/water supply and demand
 - GIS—multiple effects
- NEED: More tribal engagement

Priority Problem: Recreation/Environmental

- NEED: More/better research on vegetation uses
 - Kinds of vegetation
- NEED: Research on effective bioremediation
- NEED: Research on sustainable vegetative management
- NEED: Assign \$ value to aesthetics, environmental values (1 vote)
- NEED: Research on examples of banking, etc. to provide water for environmental purposes

Solutions

- SOLN: Conserve water and energy
- SOLN: Feds should provide incentives for consumers to buy energy/water efficient products (Ex. CFL bulbs)
- SOLN: Research what products actually save water/energy
- SOLN: Develop ET controllers for delivering/managing water
- SOLN: Standardize conservation technologies
- SOLN: Tax credits
- SOLN: Building codes
- SOLN: Certification

- SOLN: Retrofits
- SOLN: More investment in translational science
 - Support interdisciplinary education/programs
- SOLN: Rate relief pre-approval or federal incentives for new technology
 - Federal incentive program
 - Studies/prototypes
- SOLN: Need a system to provide incentives for conservation, optimization, state of solutions, to recognize watersheds
 - models
- SOLN: Need to connect science and decisionmaking
 - Climate change
 - Look at the effect of energy production on climate change
- SOLN: Hold workshops for decisionmakers. Go to local groups. Education for decisionmakers.
- SOLN: Research climate change—hydrologic cycle.
- SOLN: Case studies on effective water/energy efficiencies
 - Successes
 - Failures
 - Studies
- SOLN: Support smaller communities through education, capacity building, etc.
- SOLN: Energy efficient recovery of recycling
- SOLN: Technologies
 - Treatment—cheaper and more energy efficient
 - Return flows
 - Natural cycle technologies
- SOLN: Support organic farming
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